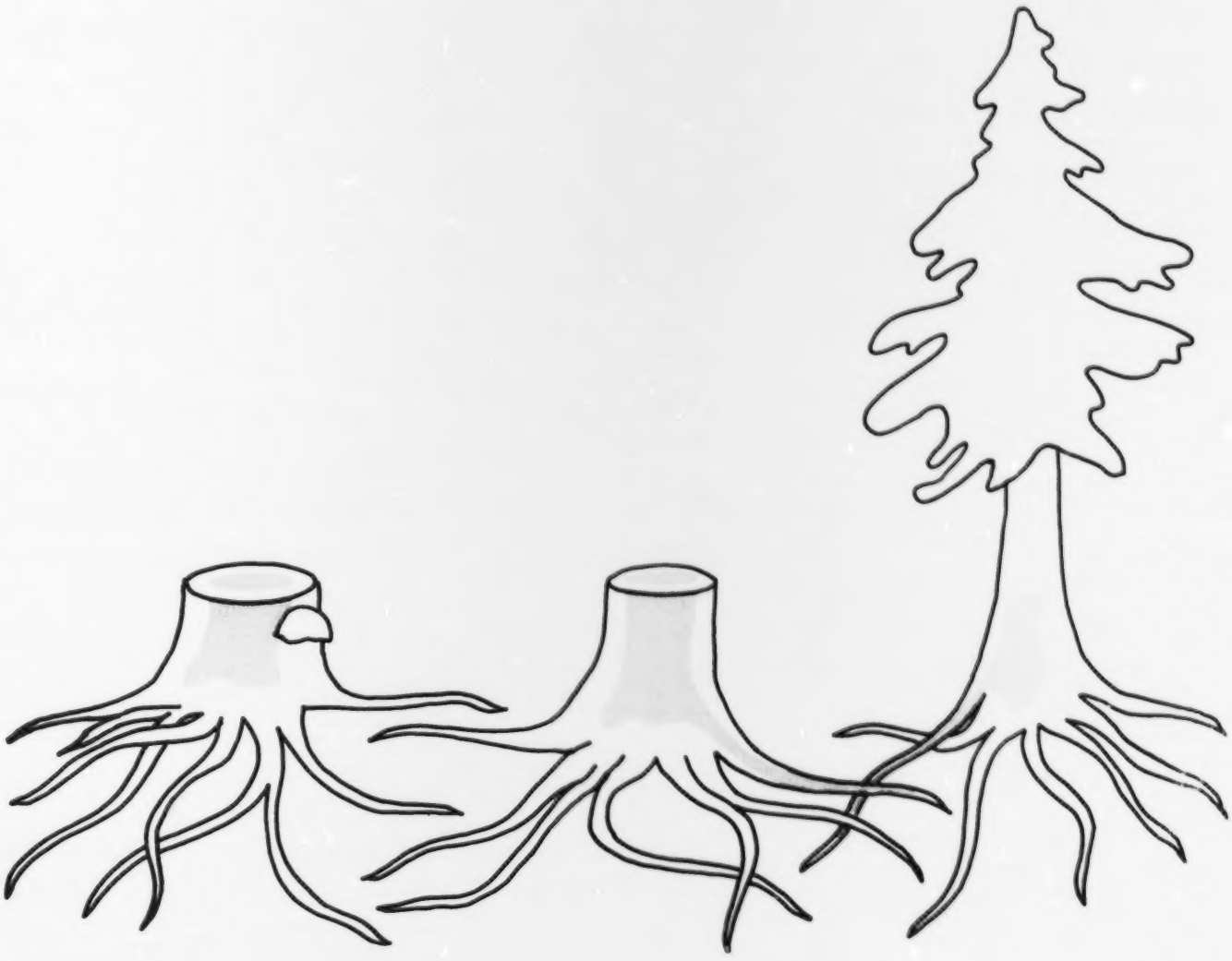
Government of Canada | Gouvernement du Canada
Canadian Forestry Service | Service canadien des forêts

Stump infection by *Fomes annosus* in spaced stands in the Prince Rupert Forest Region of British Columbia

D.J. Morrison, M.D. Larock and A.J. Waters

Information Report BC-X-285
Pacific Forestry Centre



86-06120/

Stump infection by *Fomes annosus* in spaced stands in the Prince Rupert Forest Region of British Columbia

D.J. Morrison

Canadian Forestry Service
Pacific Forestry Centre
506 West Burnside Road
Victoria, B.C., Canada V8Z 1M5

and

M.D. Larock[1] and A.J. Waters[2]

British Columbia Ministry of Forests
Research Branch
Smithers, B.C., Canada V0J 2N0

[1] Present address: B.C. Ministry of Forests, North Coast Forest District, Prince Rupert, B.C. V8J 1B9

[2] Present address: Box 555, Fraser Lake, B.C. V0J 1S0

Canadian Forestry Service
Pacific Forestry Centre

BC-X-285

1986

Canadian Forestry Service
Pacific Forestry Centre
506 West Burnside Road
Victoria, B C.
V8Z 1M5

© Minister of Supply & Services Canada, 1986
ISSN 0830-0453
ISBN 0-662-14788-X
Cat. No. Fo46-17/285E

Abstract

In spaced stands in the Prince Rupert Forest Region, stumps of western hemlock (*Tsuga heterophylla* [Raf.] Sarg.), amabilis fir (*Abies amabilis* [Dougl.] Forbes), Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco), Sitka spruce (*Picea sitchensis* [Bong.] Carr.) and lodgepole pine (*Pinus contorta* var. *latifolia* Engelm.) were sampled and the percentage of surface area colonized by *Fomes annosus* (Fr.) Karst. was determined. Susceptibility of these species, in terms of the percentage of stumps colonized, was in the following decreasing order: amabilis fir, Sitka spruce, western hemlock and Douglas-fir. *Fomes annosus* was not detected in any lodgepole pine stump. Fewer stumps were colonized in a hemlock-amabilis fir stand spaced during winter than in an adjacent stand spaced in late spring; the difference was attributed to the effects of cold temperatures and heavy precipitation on aerial spore populations. Other Basidiomycetes isolated from stumps appeared to restrict or prevent colonization by *F. annosus*. There was a significant correlation between per cent stump surface area colonized and per cent root volume colonized by *F. annosus* for amabilis fir and western hemlock stumps. *Fomes annosus* had spread from a colonized root on three of the excavated stumps to or into contacting roots of adjacent leave trees. The need to control spore infection of stumps is assessed.

Résumé

Dans des peuplements de la région forestière de Prince Rupert où un dégagement avait été effectué, des souches de pruches occidentales (*Tsuga heterophylla* [Raf.] Sarg.), de sapins gracieux (*Abies amabilis* [Dougl.] Forbes), de douglas taxifoliés (*Pseudotsuga menziesii* [Mirb.] Franco), d'épinettes de Sitka (*Picea sitchensis* [Bong.] Carr.) et de pins tordus (*Pinus contorta* var. *latifolia* Engelm.) ont été échantillonnées, et le pourcentage de la surface colonisée par *Fomes annosus* (Fr.) Karst. a été déterminé. La vulnérabilité des différentes espèces, telle qu'indiquée par le pourcentage de la surface colonisée, est dans l'ordre suivant: sapin gracieux, épinette de Sitka, pruche occidentale et douglas taxifolié. *Fomes annosus* n'a été décelé sur aucune souche de pin tordu. On a observé moins de souches colonisées dans un peuplement de pruche et de sapin gracieux où le dégagement avait eu lieu au cours de l'hiver que dans un peuplement adjacent où il avait été effectué à la fin du printemps; la différence est attribuée aux effets des basses températures et des fortes précipitations sur les populations aériennes de spores. D'autres basidiomycètes isolés sur les souches semblent avoir limité ou empêché la colonisation par *F. annosus*. Une forte corrélation existe entre le pourcentage de la surface colonisée et le pourcentage du volume des racines colonisées par *F. annosus* dans le cas du sapin gracieux et de la pruche occidentale. Dans trois des souches creusées *F. annosus* s'est propagé à partir d'une racine colonisée à des racines d'arbres feuillus adjacents avec lesquelles elle était en contact. La nécessité de lutter contre l'infection des souches par les spores est examinée.

Contents

Abstract/Résumé 3

Introduction 6

Methods 6

Results 6
- Stump Colonization 6
- Stump Excavations 7
- Other Fungi Colonizing Stumps 10

Discussion 10

References 12

Introduction

Fomes annosus (Fr.) Karst. [*Heterobasidion annosum* (Fr.) Bref. was found during cull studies of old-growth Sitka spruce [*Picea sitchensis* (Bong.) Carr. (Bier *et al.* 1946), western hemlock [*Tsuga heterophylla* (Raf.) Sarg. (Foster and Foster 1951; Foster *et al.* 1958) and amabilis fir [*Abies amabilis* (Dougl.) Forbes (Foster *et al.* 1958) in the Prince Rupert Forest Region of British Columbia and in southern Alaska (Kimmey 1956). In most stands the fungus caused minor amounts of butt rot.

Old-growth stumps and debris colonized by *F. annosus* are sources of inoculum for infection of second-growth trees through root contact (Wallis and Reynolds 1970). In addition, basidiospores produced by sporophores on this residue infect fresh stumps and wounds in spaced and commercially thinned stands (Wallis and Morrison 1975). Aerial spore populations in parts of the Prince Rupert Region (Morrison unpublished) and southern Alaska (Shaw 1981) are often high, but they are variable due to frequent precipitation. Spore infection and colonization of stumps in spaced or thinned second-growth stands result in a buildup of *F. annosus* inoculum (Morrison and Johnson 1978) and when roots of residual trees contact this inoculum, the fungus may cause root and butt decay (Wallis and Reynolds 1970).

The objectives of this study were to determine the incidence of stump colonization by *F. annosus* in spaced stands in the Prince Rupert Forest Region, to measure spread from colonized spacing stumps to residual trees and to assess the need to control spore infection of stumps.

Methods

In the Lakes, Morice, Mid-coast[3], North-coast, Queen Charlotte, and Kalum Forest Districts, 24 stands spaced 1 to 8 years previously were selected (Fig. 1). Stands were 12 to 37 years old when they were spaced. In each stand, stumps were sampled along random transects. After cutting and discarding 5 to 10 cm from the top, a disc 3 to 5 cm thick was cut from each stump. Discs were incubated between layers of moist newspaper for 5 to 7 days. At the laboratory, discs were examined for the imperfect stage of *F. annosus* using a dissecting microscope. The percentage of stump surface area colonized by *F. annosus* was calculated.

In the Kalum District, three western hemlock and 11 amabilis fir stumps with more than 10% of their surface area colonized by *F. annosus* were excavated. Preliminary observations indicated that in stumps with 10% or more of their surface area colonized, *F. annosus* was usually present in one or more roots. Each stump was sectioned and all roots 1 cm or more in diameter were cut into lengths of about 50 cm and split longitudinally. Where a stump root contacted a root of a residual tree, the latter was excised and split. The stump and all roots were incubated and examined, as above. The total stump and root volume and the volume colonized by *F. annosus* were calculated. Isolations were made from a sample of discs from some stands by placing 3 mm cubes of stained or decayed wood on malt extract agar containing benomyl. All Basidiomycetes were identified.

Results

Stump Colonization

There was significant variation among the five species in the percentage of spacing stumps colonized by *F. annosus* and in the percentage of stumps with more than 10% of their surface area colonized (Table 1). For both colonization parameters, species susceptiblity was, in decreasing order, amabilis fir, Sitka spruce, western hemlock, Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco and lodgepole pine [*Pinus contorta* Dougl. var *latifolia* Engelm.. *Fomes annosus* was not detected in any lodgepole pine stumps. The Mann-Whitney test (Siegel 1956) showed significant differences ($P = .05$) between amabilis fir, Sitka spruce and western hemlock, and Douglas-fir, and lodgepole pine in percentage of stumps colonized (Table 1). Significantly more ($P = .05$) amabilis fir stumps had more than 10% of their surface area colonized than Sitka spruce and western hemlock or Douglas-fir and lodgepole

[3] Subsequent to this study, the Mid-coast District was transferred to the Vancouver Forest Region.

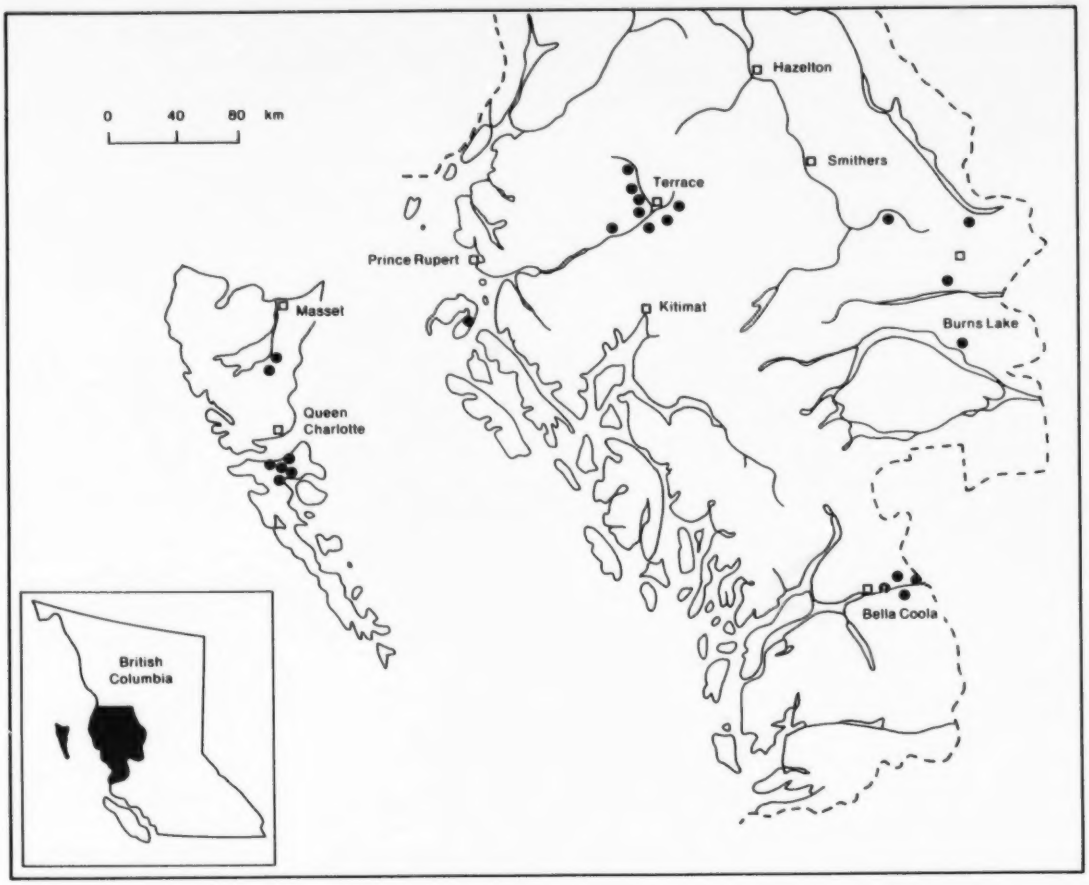


Figure 1. Locations of the 24 spaced stands in the Prince Rupert Forest Region.

pine (Table 1). Most stumps with more than 10% of their surface area colonized were larger than 10 cm in diameter.

In the Kalum District, adjacent stands of similar age and composition had been spaced in winter 1978 and in spring 1979. One year after spacing, the percentage of stumps colonized and the percentage of stumps with more than 10% of their surface area colonized were much higher in the stand spaced in spring than in winter (Table 2). Weather records for Terrace show that mean daily temperature was less than 0°C from November to February inclusive, with 44% of 565 mm of precipitation as snow (Anon. 1978, 1979).

Two stands were sampled twice, one and three years after spacing, with different stumps being sampled on each occasion. In both stands, the percentage of hemlock and amabilis fir stumps with *F. annosus* declined in the interval between samples (Table 3). However, in stand A, the percentage of stumps with more than 10% of their surface area colonized remained virtually constant, whereas in stand B, the percentages declined.

Stump Excavations

The 11 amabilis fir stumps that were excavated had a larger mean percentage of their surface area colonized than the three western hemlock stumps (Table 4). Similarly, the mean maximum distance from the root collar that *F. annosus* had grown along roots and the percentage of stump and root volume colonized were greater in ama-

TABLE 1. Percentage of stumps colonized by *Fomes annosus* in spaced stands in the Prince Rupert Forest Region.

Species	Forest Districts	No. Stands	Stand Age (yr.)	Stumps examined	Percentage of Stumps colonized by *F. annosus*	
					Total	With more than 10% surface area colonized
					%	
hemlock	Queen Charlotte Kalum North Coast Mid-coast	17	13-20	888	11.7a[1]	3.5b
amabilis fir	North coast Kalum Mid-coast	12	12-20	621	27.4a	16.7a
Sitka spruce	Queen Charlotte North Coast Mid-coast	8	14-20	148	23.6a	4.0b
Douglas-fir	Mid-coast	4	12-14	163	3.1b	1.2c
lodgepole pine	Kalum Morice Lakes	5	20-37	448	0b	0c

[1] In each column, means followed by a different letter are significantly different (P = .05).

TABLE 2. Percentage of hemlock and amabilis fir stumps colonized by *Fomes annosus* in stands spaced during winter and spring.

Species	Season	Percentage of Stumps colonized by *F. annosus*	
		Total	with more than 10% surface area colonized
hemlock	winter	0	0
	spring	35	6
amabilis fir	winter	19	0
	spring	53	26

TABLE 3. Percentage of stumps colonized by *Fomes annosus* one and three years after spacing.

Stand	Years since spacing	Hemlock		Amabilis fir	
		Percentage of stumps colonized by *F. annosus*		Percentage of stumps colonized by *F. annosus*	
		Total	with more than 10% surface area colonized	Total	with more than 10% surface area colonized
A	1	35	6	53	26
	3	11	7	36	31
B	1	7	7	64	18
	3	4	2	15	9

TABLE 4. Colonization of 14 amabilis fir and western hemlock stumps by *Fomes annosus*.

Species	Stump Diameter (cm)	Stump Surface Area Colonized (%)	Stump and Root Volume Colonized (%)	Length of *F. annosus*		
				stump	root	total[1]
hemlock (3 stumps)						
mean	14	23	24	22	8	30
range	10-18	18-31	11-44	18-27	0-18	22-36
amabilis fir (11 stumps)						
mean	15	34	41	22	37	60
range	12-19	8-75	16-84	8-47	0-99	21-119

[1] Distance from the stump top that *F. annosus* had grown.

bilis fir stumps. For the 14 stumps excavated there was a significant ($P = 0.01$) positive correlation ($r = + 0.845$) between the percentage of volume colonized and the percentage of surface area colonized ($y = 7.70 + 0.931 \times$).

There was frequent contact and grafting between roots of stumps and those of leave trees. *Fomes annosus* had grown from a diseased root on two amabilis fir stumps into grafted roots on adjacent leave trees; growth into leave tree roots averaged 17 cm. In a third amabilis fir stump, the fungus had reached a contact with a leave tree root.

Other Fungi Colonizing Stumps

About 32% of all stumps sampled, except those of lodgepole pine, were colonized to some extent by an *Armillaria* species which was identified as Group V of Anderson and Ullrich (1979). There was little difference among tree species in percentage of stumps colonized by *Armillaria*. Other Basidiomycetes isolated included: *Haematostereum sanguinolentum* (Alb. et Schw: Fr.) Pouz. and *Sistotrema brinkmannii* (Bres.) J. Erikss. from western hemlock, amabilis fir, Sitka spruce and Douglas-fir; *Polystictus versicolor* (L.) Fr. from western hemlock and Douglas-fir and *Nematoloma capnoides* (Fr.) Karst. from western hemlock.

Lodgepole pine stumps were well colonized by one or more of *Peniophora gigantea* (Fr.) Massee, *H. sanguinolentum*, *S. brinkmannii* and *Peniophora phlebioides* Jacks. and Deard., in decreasing order of frequency, as well as by fungi of the blue-stain group.

Discussion

Fomes annosus was not found in lodgepole pine, although stumps of the species are susceptible to spore infection (Wallis and Reynolds 1970; Redfern 1982). The pine stands in the Morice and Lakes districts are 70 to 150 km east of the western hemlock biogeoclimatic zone (Krajina 1965) where the fungus is detected most frequently. Hence, there may be little or no inoculum present in these districts. In contrast, the pine stand in the Kalum District, growing on a well-drained, coarse-textured soil, was surrounded by immature hemlock-amabilis fir stands. In similar hemlock-amabilis fir stands in the district, 10 to 45% of spacing stumps were colonized by *F. annosus*, indicating that abundant inoculum was present. Nearly all lodgepole pine stumps in the Morice, Lakes and Kalum districts were well colonized by one or more of a number of Basidiomycetes that are primary colonizers (Meredith 1959). The most common of these, *P. gigantea*, is used to control infection of pine stumps by *F. annosus* (Rishbeth 1963). These fungi appear to be better colonizers of pine stumps than *F. annosus* and may exclude the latter.

Colonization of stumps by *Armillaria* group V usually begins from rhizomorphs present on the root system at the time of felling; colonization of root wood follows rapid spread in the cambial zone (Morrison and Johnson 1978). In such stumps *F. annosus* entering through the cut surface is usually confined by *Armillaria* to the central root tissues, thereby reducing the likelihood of spread to leave trees in contact. *Armillaria* group V is not pathogenic on conifers.

The decline in percentage of hemlock and amabilis fir stumps colonized by *F. annosus* during the two-year interval between samples is similar to that recorded by Dimitri *et al.* (1971) in Norway spruce (*Picea abies* L.) and by Morrison and Johnson (1978) in western hemlock and Douglas-fir. In stand A (Table 3), the decline was due to the disappearance of *F. annosus* from stumps with less than 10% of their surface area colonized, whereas there was a general decrease in the amount of *F. annosus* in stumps of stand B. The reason for the difference is unclear, since the stands were spaced in the same year and season and were the same age (20 years); the slightly larger average stump diameter in stand B (12.5 cm vs. 10 cm) does not account for the difference in colonization.

There was a much lower incidence and less surface area colonized in winter-cut stumps in two adjacent hemlock-amabilis fir stands near Terrace. A similar seasonal effect was observed at Jordan River (Morrison and Johnson 1970) in stumps of hemlock and amabilis fir, however the effect was much less pronounced. Precipitation and temperatures near freezing reduce the aerial spore population of *F. annosus* and spore production ceased when temperatures were below freezing (Reynolds and Wallis 1966). Results presented by Redfern (1982) suggest that stump infection in Sitka spruce stumps may be reduced by

high rainfall. At Terrace, the low incidence of infected stumps and stump surface colonized during winter may be attributed to low spore inoculum levels that are caused by low temperatures and heavy precipitation.

The significant correlation between surface area colonized and stump and root volume colonized suggests that about 15% of amabilis fir stumps and 4% of Sitka spruce and hemlock stumps could have *F. annosus* in their roots. The high frequency of root contacts and grafts in the dense stands facilitates spread to leave trees.

The incidence of stump infection, number of well-colonized stumps and degree of root colonization by *F. annosus* indicate that stump treatment to prevent infection should be considered, particularly in stands containing amabilis fir. At present, borax is the only chemical registered as a stump protectant against *F. annosus*; it is applied to stumps as a powder on 10% aqueous suspension. Spacing in winter may be an alternative to chemical treatment, however, further sampling is needed to confirm the above results.

Acknowledgement

The Authors are indebted to Dorothy Chu for identifying cultures and to Dr. C.S. Simmons for statistical analyses.

References

Anderson, J.B. and R.C. Ullrich. 1979. Biological species of *Armillaria mellea* in North America. Mycologia 71: 402-414.

Anon. 1978. Monthly record. Meteorological observations in western Canada 63.

Anon. 1979. Monthly record. Meteorological observations in western Canada 64.

Bier, J.E., R.E. Foster and P.J. Salisbury. 1946. Studies in forest pathology. IV. Decay of Sitka spruce on the Queen Charlotte Islands. Dom. Canada Dept. Agric. Tech. Bull. 56.

Dimitri, L., H. Zycha and R. Kliefoth. 1971. Untersuchungen Û ber die Bedeutung der Stubben infektion durch *Fomes annosus* fÛr die Ausbreitung der RotfÂule der Fichte. Forstwiss. Centrabl. 90: 104-117.

Foster, R.E. and A.T. Foster. 1951. Studies in forest pathology VIII. Decay of western hemlock on the Queen Charlotte Islands, British Columbia. Can. J. Botany 29: 479-521.

Foster, R.E., J.E. Browne and A.T. Foster. 1958. Studies in Forest Pathology XIX. Decay of western hemlock and amabilis fir in the Kitimat region of British Columbia. Forest Biol. Div., Canada Dept. Agric. Publ. 1029.

Kimmey, J.W. 1956. Cull factors for Sitka spruce, western hemlock and western red cedar in southeastern Alaska. U.S. For. Serv., Alaska For. Res. Stn. Pap. 6. 31pp.

Krajina, V.J. 1965. Biogeoclimatic zones and classification of British Columbia. *In* Ecology of Western North America. ed. V.J. Krajina. Bot. Dept. Univ. of British Columbia 1: 1-17.

Meredith, D.S. 1959. Infection of pine stumps by *Fomes annosus* and other fungi. Ann. Bot., N.S. 23: 455-476.

Morrison, D.J. and A.L.S. Johnson. 1970. Seasonal variation of stump infection by *Fomes annosus* in coastal British Columbia. For. Chron. 46: 200-202.

Morrison, D.J. and A.L.S. Johnson. 1978. Stump colonization and spread of *Fomes annosus* 5 years after thinning. Can. J. For. Res. 8: 177-180.

Redfern, D.B. 1982. Infection of *Picea sitchensis* and *Pinus contorta* stumps by basidiospores of *Heterobasidion annosum*. Eur. J. For. Path. 12: 11-25.

Reynolds, G and G.W. Wallis. 1966. Seasonal variation in spore deposition of *Fomes annosus* in coastal forests of British Columbia. Can. For. Serv. Bi-monthly Res. Notes 22: 6-7.

Rishbeth, J. 1963. Stump protection against *Fomes annosus*. III. Inoculation with *Peniophora gigantea*. Ann. Appl. Biol. 52: 63-77.

Shaw, C.G. III. 1981. Infection of western hemlock and Sitka spruce thinning stumps by *Fomes annosus* and *Armillaria mellea* in southeast Alaska. Plant Dis. 65: 967-971.

Siegel, S. 1956. Nonparametric statistics for the behavioural Sciences. McGraw-Hill, New York. 312 pp.

Wallis, G.W. and G. Reynolds. 1970. *Fomes annosus* root and butt rot: A threat in coastal British Columbia. For. Chron. 46: 221-224.

Wallis, G.W. and D.J. Morrison. 1975. Root rot and stem decay following commercial thinning and guidelines for reducing losses. For. Chron. 51: 203-207.